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Carolina Parente Robalo

Estratégias de Preservação da Artéria Ilíaca Interna no Tratamento Endovascular de Aneurismas Aortoilíacos

Internal Iliac Artery Preservation Strategies in the Endovascular Treatment of Aortoiliac Aneurysms

março, 2018

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Internal Iliac Artery Preservation Strategies in the Endovascular Treatment of Aortoiliac Aneurysms

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Carolina

Internal iliac artery preservation strategies in the endovascular treatment of aortoiliac aneurysms

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ABSTRACT

INTRODUCTION: Common iliac aneurysms are present in up to 40% of abdominal aortic aneurysms and frequently impair distal landing zones for endovascular aneurysm repair. Several techniques have been developed in order to overcome these issues, with different applications and conflicting results. Although long-term outcomes of hypogastric exclusion are favorable, the risks of pelvic ischemia and morbidity rates are high. We aim to review current hypogastric preservation strategies used in the endovascular treatment of aortoiliac aneurysms.

EVIDENCE ACQUISITION: A thorough non-systematic review of the literature was conducted using PubMed/Medline. Forty-five articles were included, according to their scientific relevance and relation with the subject.

EVIDENCE SYNTHESIS: The bell-bottom technique can be used in common iliac arteries with up to 24mm of diameter. Although apparently effective in the short-term, long-term durability is questionable with reported type 1b endoleak rates varying from 3,4-7,8% and high re-intervention rates reported. Iliac branches have better long-term outcomes, with 90,4% patency rates and 91,8% freedom from re-intervention at 10 years' follow-up. Nonetheless, its widespread application is limited by complex anatomies and increased costs. Finally, parallel-graft techniques are an effective option for hostile anatomies unsuitable for other techniques. Endoleak due to gutter development remains the biggest limitation for its long-term durability and solid evidence regarding its application is still lacking.

CONCLUSIONS: When determining the appropriate hypogastric preservation strategy, several factors should be considered. Anatomic criteria, life-expectancy as well as physical and sexual activity are the most important criteria. Procedure complexity and cost should also be accounted for.

Keywords: Iliac aneurysm; embolization; iliac branch; bell-bottom; parallel graft

INTRODUCTION

Abdominal aortic aneurysm (AAA) is defined by an aortic diameter equal or superior to 30mm.[1] Its estimated prevalence amongst men over the age of 50 is 5%[1] and increases with age, so that it can reach 12,5% in men and 5,2% in women of 74 to 84 years of age.[2] Although it may be clinically silent, its rupture is a medical emergency, with mortality rates of approximately 80%.[2, 3] Elective treatment is therefore essential.

In the earlier days, AAA's were only manageable through open surgical repair. This was an effective treatment option, although associated with major complications, particularly in patients with higher co-morbidity rates. Later, with the advent of Endovascular Aneurysm Repair (EVAR), this paradigm shifted. Compared to open repair, EVAR significantly decreases blood loss, operative time, hospitalization time and morbidity rates,[4, 5] broadening the treatment options for patients who would otherwise be deemed unsuitable.[6] Nonetheless, this technique is not devoid of limitations, and re-intervention rates are higher among these patients. Also, standard EVAR requires anatomic suitability to be implanted, and in only 50-70% of AAA's that is observed.[6]

In fact, in order to achieve proper aneurysm exclusion through EVAR, appropriate seal, both proximal and distal, is necessary, and although instructions for use (IFU's) differ depending on the manufacturer, minimum landing zones of 10-15mm are consensual. Since approximately 20% of AAA's extend to the iliac bifurcation[7] and uni or bilateral iliac aneurysms may exist in up to 40% of AAA's,[8, 9] these conditions are frequently difficult to obtain.

Inappropriate landing zones, in association with further aneurysmal degeneration of the iliac arteries after EVAR, can lead to endoleak or stent-graft migration,[10] and therefore increase the risk of rupture. In order to overcome this issue, several techniques have been developed and implemented throughout the years. However, they present somewhat different applications and conflicting results.

Through this article, we aim to review current internal iliac artery (IIA) preservation strategies used in the treatment of aortoiliac aneurysms.

EVIDENCE ACQUISITION

A thorough literature search was carried using Pubmed/Medline relative to articles published until September 2007 and using the following keywords: "iliac aneurysm", "iliac branch", "parallel graft" and "bell-bottom". From this research, one hundred and twenty-four articles were obtained. Only english-written articles published in the last ten years were accepted, and case reports were excluded from this review. In order to assure that all relevant articles were included, no other significant limits were imposed. From this selection, forty articles were excluded.

All remaining eighty-four abstracts were accessed and seventeen were excluded for not being directly related with the subject, namely those approaching disease other than aortoiliac aneurysms or results on the proximal, rather than the distal sealing after EVAR.

From the remaining sixty-seven, thirty-eight articles were included, according to the author's preference and scientific relevance in the context of the proposed theme. A further manual search was conducted in order to further explore the epidemiology of AAA and technique results and seven articles were added. A total of forty-five articles were included (Figure 1).

EVIDENCE SYNTHESIS

DELIBERATE HYPOGASTRIC ARTERY OCCLUSION

Deliberate occlusion of one or both of hypogastric arteries with distal seal in healthy external iliac artery (rather than in the common iliac artery), was the first technique developed to overcome sealing issues. Although current literature reports good long-term outcomes, high technical success and low endoleak rates,[11] this technique is not devoid of complications. In fact, it is accompanied by a fairly worse clinical outcome, since up to 50%[7] of the patients develop complications due to pelvic ischemia, with considerable impact in their quality of life and even risk of death. These pelvic ischemic symptoms are many, and vary in frequency and severity. The most common symptom reported is buttock claudication, affecting up to 28-42% of the patients, followed by vasculogenic impotence, reported in 17-24% of the cases.[12] These are rather benign complications, although there are others such as bowel ischemia (3,4%), spinal cord ischemia (0,1-0,3%), sciatic nerve ischemia, sloughing of the scrotal skin, severe rest pain, paraplegia, and sacral tissue loss,[12-14] which are considerably more severe and even potentially fatal.

Over the years, changes to the standard procedure have been implemented in an attempt to reduce these complications. For instance, it was proposed that the interruption of the IIA should be performed as proximally as possible, in order to preserve the IIA bifurcation[15] and seek a better conservation of collateral blood supply.[13] Other techniques such as flush coverage of the IIA origin[14] or even staged occlusion when bilateral intervention is necessary, were performed, although with no differences in the reported rate of complications. This is explained by the fact that hypogastric artery exclusion is an acute process, and therefore new ischemia-induced branch expansion is impossible. As a result, the presence or absence of symptoms highly depends on the pre-existing collateral circulation of the external iliac artery, *profunda* femoris arteries, mesenteric arcades and contralateral hypogastric artery.[16]

It is also important to emphasize that patients with vascular disease and aneurysm formation, often simultaneously present with chronic embolization from mural thrombus of the aneurysm and/or concomitant atherosclerotic processes within the pelvic arteries. This may impair collateral branch irrigation, even if those branches do exist, making it difficult to predict which patients are more likely to develop complications and to what extent, solely based on the image study of the collateral circulation.[8] Based on this, and even though long-term outcomes of hypogastric embolization are

favorable, the risks of pelvic ischemia are too high, and preservative strategies aiming to preserve hypogastric flow, have been created.

INTERNAL ILIAC ARTERY PRESERVATION STRATEGIES

Over the years, several techniques have been developed in an attempt to both grant proper distal seal and preserve the hypogastric artery in aortoiliac aneurysms.

Hybrid techniques were the first to be employed, with somewhat mixed results. These ranged from primary hypogastric artery bypasses to common iliac artery bandings for smaller aneurysms and, although effective, usually required retroperitoneal incisions, therefore contradicting the concept of minimally invasive approach, which represents one of the main advantages of EVAR.[4] Also, these hybrid approaches can be technically challenging, mainly in obese patients, narrow pelvises or larger aneurysms, as well as those submitted to previous pelvic surgery or radiation.[14]

In order to overcome these limitations, several endovascular techniques have been developed, with conflicting applications and results. These vary from iliac branches to bell-bottom or parallel graft techniques, and will be considered in the following paragraphs.

1. BELL-BOTTOM TECHNIQUE

The bell-bottom or flared limb technique was first published in 1999,[17] and employs flared limb devices in order to adequately obtain seal in a dilated common iliac artery (CIA). Both reversed extension limbs and aortic cuffs[17] can be used, and since the largest available diameter of the flared limb stent graft is 28mm, it may be applied to CIA's with a maximum diameter of 24mm.[11] It is rather unexpensive and technically simple, making it a good treatment option readily available in all vascular centers.

Nonetheless, and even though this technique represents a treatment option for numerous aneurysms, it is anatomically restrictive, demonstrating limited benefit for patients with larger aneurysms or IIA involvement.[7] Also, long-term durability seems to be an issue, as reported by some authors who consider that, since landing is obtained in an unhealthy vessel segment, continuous pressure to the ectasic or aneurysmal tissue occurs, eventually leading to further dilation of the distal landing zone, with endoleak and increased risk of rupture.[4]

Several studies have been conducted on this matter and the reported results are controversial (Table I). Torsello *et al* studied the use of bell-bottom with flared limbs in CIA aneurysms with diameters between 20-30mm.[18] The type 1b endoleak rate observed was 3,4%, with CIA diameter increases in 4,4% of cases, from which the technique was deemed appropriate for CIA with up to 30mm of diameter.[18] Alverez M. *et al* studied the short-term outcomes of the use of aortic extenders in aneurysms with a diameter up to 25 mm, with similar technical and clinical success rates as the ones reported in previous series.[17] On the other hand, Telles *et al*, in a recent follow-up study, noted that after using the bell-bottom technique in patients with a CIA of 15 mm or more, further dilation occurred in 35,3% of the patients.[19] In the same study, the reported endoleak rate was 17,6% (with 7.8% type 1b and 9.8% type II) and re-intervention was needed in 15,7% of cases (more frequent in younger patients and those with more risk factors).[19] On another study, Gray *et al* observed a significant difference in the type 1b endoleak incidence after bell-bottom in a group treated with iliac limbs of 20mm of diameter or more (18%), when compared to a group treated with regular limbs (4%). The first group of patients were 5,3 times more likely to develop a type 1b endoleak than the other group, regardless of the effectiveness of the initial seal.[20]

In summary, the bell-bottom technique is a safe, feasible and unexpensive treatment option for ectasic CIAs or those that present small aneurysms. However, further aneurysmal degeneration seems to be associated with long-term type 1b endoleak and higher re-intervention rates. Long-term follow-up studies are necessary to assess the real advantages of this technique, in view of possible negative future outcomes.

2. ILIAC BRANCHES

Iliac branches were first introduced in 2006, as an alternative to hypogastric embolization in the endovascular treatment of aortoiliac aneurysms.[21] These are bifurcated grafts with a small lateral branch, and allow hypogastric artery preservation through a bridged covered stent. Unlike the bell-bottom technique, iliac branches can be used in large aneurysms, although their implantation is more complex and certain anatomic restrictions are also present.

2.1 - Anatomic considerations

Standardized anatomical criteria for the use of iliac branches have not yet been established. Nonetheless, there are some known individual factors that should be considered, as they may increase the procedure's technical difficulty and/or the risk for post-operative complications related to the graft patency. These include excessive iliac tortuosity, calcifications, intraluminal CIA thrombus or IIA stenosis.[4, 13] Therefore, and although the devices should be applied according to their IFU's, a case-by case evaluation of complex anatomy is necessary with appropriate pre-operative planning.[22]

The presence of IIA aneurysms also jeopardizes the effectiveness of iliac branches, and must be accounted for.[23] When present, proper landing zone for the iliac component may not be available, therefore bearing high endoleak and re-intervention risks. Nonetheless, and although the IIA diameter is often one of the most prominent adverse anatomical features for iliac branch deployment,[12, 24] it may not always be an exclusion factor. In fact, treatment of IIA aneurysms with iliac branches extending to the superior gluteal artery has been attempted with satisfactory results, as reported by M. Noel-Lamy et al in a series of 15 patients.[25] Despite effective, these procedures are usually more complex and therefore more prone to complications.

2.2 - Technical and clinical outcomes

Since iliac branches were first introduced, a significant increase in both technical success and patency rates were observed (Table II). Nowadays, technical success ranges from 85% to 96,3% [11] and even reaches 100% in smaller series.[7, 11, 13] This reflects not only a general improvement of the devices, but also, better patient selection as well as an improvement in procedure-related learning curve.[8, 11]

Regarding clinical outcomes (Table II), current evidence reports 5-year patency rates of 88%-91,4%,[11, 26] with freedom from re-intervention of 81,3%.[26] Branch graft occlusion rates are of 1,2-12,2%[11, 13], which may or may not be symptomatic, as reported by A. Karthikesalingam *et al,* who, in a series 196 iliac branches with a 12,2% occlusion rate, demonstrated that only half of these developed symptomatic buttock claudication.[13]

Similarly to conventional EVAR procedures, endoleak remains a great concern in iliac branch implantations. Type 2 endoleak is the most common, with rates fluctuating between 0 to 15.8%.[7] Type 3 endoleak is less frequent, affecting up to 7,14% of the patients,[8] although, unlike type 2, requires a more active and immediate treatment to prevent aneurysm rupture as a consequence of its continuous pressurization.[8, 27] Type 1 endoleak may also occur in up to 5%[28] and requires immediate intervention as well.[29]

Unlike the bell-bottom technique, there are long-term follow-up studies available regarding iliac branches, which generally report favorable outcomes for this technique.

Jongsma *et al* studied the outcomes of 140 patients throughout 11 years and reported a technical success of 96,9%, with considerable sac regression obtained in 51,3% of the patients. On the other hand, sac enlargement was observed in 13,1% patients, half of them due to type 1 or type 3 endoleaks. IIA branch occlusion occurred in 9,3% patients, of which, only 3,7% developed buttock claudication. Freedom from re-intervention was 75,9% after 5 years.[28]

G. Simonte *et al,* in a similar study, analyzed 149 patients throughout 10 years and described a 97,5% technical success rate, with 90,4% patency after 10 years and freedom from re-intervention of 94% and 91,8% after 5 and 10 years, respectively.[23]

Donas *et al,* in the largest series available (n=575) reported similar findings, with 85,7% overall freedom from re-intervention for type 1 endoleak or occlusions.[30]

Although this technique is complex and requires certain endovascular skills, there seems to be no significant differences in procedure time, contrast use, technical success or early deaths when compared with the bell-bottom technique, as reported by Vernizi *et al.* On the other hand, the iliac branch group had much superior results regarding endoleak rates (4% vs 19%) and pelvic ischemic symptoms (4% vs 22%) when comparing with its counterpart.[31]

3. **PARALLEL GRAFT TECHNIQUES**

Parallel graft techniques such as sandwich-graft, double-barrel, internal iliac snorkel or chimney techniques, have also been proposed as an alternative for the treatment of complex aortoiliac or

isolated CIA aneurysms.[11, 32] The most commonly used technique in this setting is the internal iliac snorkel, which consists in the implantation of a covered stent in the IIA, in a parallel configuration with the main graft, granting IIA perfusion in a retrograde fashion.[33]

Initially projected as a bailout solution for emergent situations or inadverted intraoperative vessel coverage, parallel graft techniques are now performed as elective procedures in certain cases with complex anatomy.[34] In fact, even though bell-bottom and iliac branches expanded the endovascular options in aortoiliac aneurysms, there are several anatomies in which these techniques remain inadequate.[12] Parallel graft techniques emerged as an effective treatment option for these patients that would otherwise be deemed unsuitable for endovascular repair.

Although an off-label technique, with sparse literature regarding its application in aortoiliac aneurysms, it appears to be safe and feasible, with encouraging short and mid-term outcomes (Table III). In fact, both Wu *et al*, in a series of 14 patients using the Crossover Chimney Technique,[35] and Lobato and Camacho-Lobato, in a series of 40 patients treated with the Sandwich Technique,[36] reported similar midterm results. Technical success rate was 100% and primary patency rates of 92,8% and 93,8%, respectively. Furthermore, in the second study, a decrease in iliac aneurysm diameter was found in 34,8% of patients, with no symptomatic occlusions described. All of the patients considered for the studies showed complex anatomy and did not fulfill the requirements for standard EVAR technique. Identical outcomes were reported by C.S. Lim *et al*, with 100% technical success rate, a primary patency rate of 90,5%, and significant post-operative aneurysm reduction (>5mm) in 66,7% of patients.[32]

Despite effective, the main restrain of this technique remains the post-procedure "gutter" development. It occurs when there is a loss of apposition between the parallel stent-grafts themselves and the vessel wall.[37] This can lead to a type 1 endoleak due to the interspace created between grafts, and is potentially difficult to treat.[38] Massmann *et al*, in a series of 41 patients treated with sandwich-technique to preserve hypogastric flow, described post-procedure gutter-endoleaks[20] in 6,5% of patients. Further studies are therefore required regarding long-term outcomes of this technique.

DISCUSSION

Taking into account the morbidity and even mortality associated with IIA embolization prior to EVAR, several alternatives to IIA sacrifice have emerged in recent years. These are especially important in patients expected to have higher symptom severity with hypogastric embolization, and several factors should be considered when assessing them.

In fact, the severity of symptoms is determined not only by the collateral supply existent, but also the end organ demand in the vascular territory of the IIA that would be occluded, and the baseline blood supply available. Therefore, patients with higher demand, such as younger and more active patients, as well as those whose blood supply is already diminished due to reduced cardiac output, are more likely to develop claudication upon IIA occlusion.[13] In addition, one must remember that the hypogastric arteries contribute to the collateral pathway responsible for spinal cord perfusion. Therefore, patients planned to undergo endovascular repair of more proximal aortic segments, in which intercostal branch re-implantation is not feasible,[20] as well as those with simultaneous thoraco-abdominal aneurysms, rely on the iliac circulation for spinal cord perfusion, which must be preserved at all costs. [4]

In order to achieve this, several techniques have been developed, although with different applications and conflicting results. This makes it impossible to clearly identify one technique as superior over the others, although recommendations can be issued on which technique to use in specific settings.

a) Bell-Bottom

Regarding endovascular approach to aortoiliac aneurysms, the bell-bottom technique offers a very interesting choice of treatment, both economically and result wise. In a comparative study between bell-bottom and hypogastric exclusion prior to EVAR, Naughton *et al* observed a significant lower combined incidence of complications in the bell-bottom group (22% vs 49%). Although no significant differences regarding total re-intervention rates were found between the techniques, considering that bell-bottom preserves pelvic flow, it was considered to be preferable upon availability.[15]

Despite the up mentioned results, one must recall that bell-bottom is limited by several anatomic factors. Regarding this, the same study by Naughton *et al* issued some recommendations, considering it as the preferable treatment option when CIA diameter in the sealing segment was inferior to 25mm. When a CIA bifurcation with 25mm or more, significant thrombus in the CIA or IIA aneurysm were present, hypogastric occlusion should be employed, despite higher risk of complications.[15]

Nowadays, with the development of alternative hypogastric preservation strategies, these indications have changed. Nonetheless, CIA diameter continues to be a major factor to be considered regarding recommendation for this method. Therefore, the authors consider the bell-bottom technique as an

effective option in patients with shorter life expectancy, with CIA with < 25mm in the sealing segment, and no internal iliac artery aneurysm.

b) Iliac branches

As previously discussed, iliac branches represent an effective treatment option. However, these devices have strict anatomic criteria, which can limit its applicability. Tielliu *et al*, in a series of 59 patients, reported that only 52% of patients with aortoiliac or isolated iliac aneurysms were morphologically suited for iliac branch.[39] On a similar study, Pearce *et al* studied the anatomic suitability of 99 patients for two different types of devices and, comparing the patients from both groups, only 35,4% of patients would be anatomically suited for treatment with any of the devices.[12] In a similar study by Karthikesalingam *et al*, only 29% of the internal iliac arteries were fully compatible for the devices.[24]

This low morphological suitability for iliac branch deployment has implications and suggests that the short or long-term results of iliac branch may be underestimated, due to an incorrect application of the device, resulting in increased endoleak and failure rates.[26]

Anatomical indications for iliac branches vary according to different manufacturers and types of devices employed. Therefore, respective IFUs for each device should be evaluated when accessing each patient's applicability (Table IV). Nonetheless, as previously determined, the CIA diameter is one of the anatomic key factors, especially in the scope of endovascular distal fixation.

Due to the great short and long-term results reported, iliac branches are considered as the first-line approach for CIA aneurysms with >30mm of diameter, with or without concomitant AAA.[17,23] Nonetheless, when considering CIA with shorter diameters, particularly when CIA < 25mm, a grey zone exists regarding the best technique to employ. The authors recommend that if a patient presents low life expectancy or if iliac branch has previously failed, bell-bottom should be performed; in the remaining cases, iliac branch should be the treatment of choice [10].

Also, presence of factors that increase procedure's technical difficulty and/or the risk for post interventional complications related to the graft patency should weigh in this decision. These are variable and include excessive iliac tortuosity, calcifications, IIA aneurysm or stenosis, poor runoff, sharp aortic bifurcation, intraluminal CIA thrombus, severe EIA kinking, or wide angle (>50º) of the IIA branch and IIA artery [4, 8, 13]. In the presence of multiple of these factors, the increased anatomic complexity would tilt the choice towards another technique.

In a cost-effectiveness perspective, younger, more active patients or those at higher risk of symptomatic pelvic ischemia (e.g thoracoabdominal endovascular repairs), would benefit the most from iliac branches.[13] However, different studies recommend its use, not only in these patients, but in all cases of AAA with extent to the iliac bifurcation, as long as favorable anatomy exists.[7]

c) Parallel-grafts

Despite the lack of solid evidence concerning this technique, it has gained popularity in recent years. Some authors consider it only for emergent approaches or in poor-surgical-risk patients[40]. Others advocate it should always exist as an option when dealing with complex aortic disease, since it has proven to be safe and effective in mid-term follow up studies.[34] Nonetheless, long-term follow-up studies are still lacking, and no information regarding late gutter development or graft behavior after implantation is available.

Based on this, the authors consider this an exceptional technique that should be part of any vascular surgeon's armamentarium. Nonetheless, due to the lack of long-term follow-up studies, we recommend that it should only be used as a bailout treatment option, when dealing with unsuitable anatomies for iliac branch or in emergency situations.

All in all, there are several techniques to be considered when treating aortoiliac aneurysms, and several factors should be measured upon the choice of the best treatment option. As pointed by Huilgol *et al,* [16] factors such as patient's life expectancy, their level of physical and sexual activity and the expected risk of serious ischemic complications from IIA embolization, should be assessed when choosing a treatment technique. Specific aneurysm morphology, the risks of a potentially longer procedure and associated larger contrast volumes, as well as the financial cost of the procedure and the endovascular skills required, should also be considered.

CONCLUSION

When treating aortoiliac aneurysms, endovascular options may be impaired by improper distal landing zones. Deliberate hypogastric exclusion has proved effective, although evidence reports high morbidity rates due to pelvic ischemia. IIA preservation is therefore important to be considered and the bell-bottom technique, iliac branches and parallel-graft techniques are clinically more

advantageous. Although none has proved benefits over the others, each of these techniques presents valid recommendations (Table V).

Iliac branches are the most widespread, showcasing more enticing long-term results. However, several anatomic features limit their applicability and its use in hostile anatomy may result in a decrease of its efficacy and durability. In some cases, the bell-bottom technique may be a viable option if common iliac diameter is not over 24 mm. Nonetheless, their long-term durability and higher re-intervention rates should be considered before implantation. Finally, parallel-graft techniques broadened the treatment options in complex anatomies unsuitable for other approaches, particularly in emergency situations when of-the-shelf grafts are not available. Although effective in the short-term, long-term results are still missing.

Correct patient selection is crucial for the effectiveness of the mentioned techniques. The importance of defining specific anatomic criteria for each method as well as considering individual cases of life expectancy and emergency setting upon treatment choice must not be forgotten. Further long-term studies are needed for that stratification and for the evaluation of long-term results.

REFERENCES

1. Brady AR, Thompson SG, Fowkes FG, Greenhalgh RM, Powell JT, Participants UKSAT. Abdominal aortic aneurysm expansion: risk factors and time intervals for surveillance. Circulation. 2004 Jul 6;110(1):16-21. PubMed PMID: 15210603. Epub 2004/06/24.

2. Keisler B, Carter C. Abdominal aortic aneurysm. American family physician. 2015 Apr 15;91(8):538-43. PubMed PMID: 25884861. Epub 2015/04/18. eng.

3. Thompson SG, Ashton HA, Gao L, Buxton MJ, Scott RA, Multicentre Aneurysm Screening Study G. Final follow-up of the Multicentre Aneurysm Screening Study (MASS) randomized trial of abdominal aortic aneurysm screening. Br J Surg. 2012 Dec;99(12):1649-56. PubMed PMID: 23034729. Pubmed Central PMCID: PMC3569614. Epub 2012/10/05.

4. Oderich GS, Greenberg RK. Endovascular iliac branch devices for iliac aneurysms. Perspect Vasc Surg Endovasc Ther. 2011 Sep;23(3):166-72. PubMed PMID: 21810808. Epub 2011/08/04.

5. Sousa J, Brandao D, Barreto P, Ferreira J, Almeida Lopes J, Mansilha A. [Percutaneous Endovascular Aortic Repair with Local Anesthesia - One Day Surgery]. Acta medica portuguesa. 2016 Jun;29(6):381-8. PubMed PMID: 27865218. Epub 2016/11/21. Tratamento Endovascular do Aneurisma da Aorta Abdominal por Via Percutanea e Anestesia Local - One Day Surgery. por.

6. Pua U, Tan K. Radiology of advanced EVAR techniques in complex abdominal aortic aneurysms. Eur Radiol. 2012 Feb;22(2):387-97. PubMed PMID: 21927792. Epub 2011/09/20.

7. Fernandez-Alonso L, Fernandez-Alonso S, Grijalba FU, Farina ES, Aguilar EM, Alegret Sole JF, et al. Endovascular treatment of abdominal aortic aneurysms involving iliac bifurcation: role of iliac branch graft device in prevention of buttock claudication. Ann Vasc Surg. 2013 Oct;27(7):851-5. PubMed PMID: 23540668. Epub 2013/04/02.

8. Pua U, Tan K, Rubin BB, Sniderman KW, Rajan DK, Oreopoulos GD, et al. Iliac branch graft in the treatment of complex aortoiliac aneurysms: early results from a North American institution. J Vasc Interv Radiol. 2011 Apr;22(4):542-9. PubMed PMID: 21463759. Epub 2011/04/06.

9. Zhang T, Guo W, Ma X, Jia X, Liu X, Dong Y, et al. Novel-designed iliac branch stent graft for internal iliac artery reconstruction during aneurysm repair. Ann Vasc Surg. 2015 Feb;29(2):189-96. PubMed PMID: 25305423. Epub 2014/10/12.

10. Bisdas T, Weiss K, Donas KP, Schwindt A, Torsello G, Austermann M. Use of iliac branch devices for endovascular repair of aneurysmal distal seal zones after EVAR. J Endovasc Ther. 2014 Aug;21(4):579-86. PubMed PMID: 25101590. Epub 2014/08/08.

11. Duvnjak S. Endovascular treatment of aortoiliac aneurysms: From intentional occlusion of the internal iliac artery to branch iliac stent graft. World J Radiol. 2016 Mar 28;8(3):275-80. PubMed PMID: 27027393. Pubmed Central PMCID: PMC4807336. Epub 2016/03/31.

12. Pearce BJ, Varu VN, Glocker R, Novak Z, Jordan WD, Lee JT. Anatomic suitability of aortoiliac aneurysms for next generation branched systems. Ann Vasc Surg. 2015 Jan;29(1):69-75. PubMed PMID: 25194549. Epub 2014/09/10.

13. Karthikesalingam A, Hinchliffe RJ, Holt PJ, Boyle JR, Loftus IM, Thompson MM. Endovascular aneurysm repair with preservation of the internal iliac artery using the iliac branch graft device. Eur J Vasc Endovasc Surg. 2010 Mar;39(3):285-94. PubMed PMID: 19962329. Epub 2009/12/08.

14. Lee WA. Branched Endograft for Aortoiliac Artery Aneurysms. Vascular. 2009;17(Supplement 3):S111-S8.

15. Naughton PA, Park MS, Kheirelseid EA, O'Neill SM, Rodriguez HE, Morasch MD, et al. A comparative study of the bell-bottom technique vs hypogastric exclusion for the treatment of aneurysmal extension to the iliac bifurcation. J Vasc Surg. 2012 Apr;55(4):956-62. PubMed PMID: 22226182. Pubmed Central PMCID: PMC3319281. Epub 2012/01/10.

16. Huilgol RL, Lennox A, Boyne N, Villalba L, Huber D, Goodman M. Using bilateral iliac branch devices for endovascular iliac aneurysm repair. ANZ Journal of Surgery. 2011;81(11):822-6.

17. Alvarez Marcos F, Garcia de la Torre A, Alonso Perez M, Llaneza Coto JM, Camblor Santervas LA, Zanabili Al Sibbai AA, et al. Use of aortic extension cuffs for preserving hypogastric

blood flow in endovascular aneurysm repair with aneurysmal involvement of common iliac arteries. Ann Vasc Surg. 2013 Feb;27(2):139-45. PubMed PMID: 22841756. Epub 2012/07/31.

18. Torsello G, Schonefeld E, Osada N, Austermann M, Pennekamp C, Donas KP. Endovascular treatment of common iliac artery aneurysms using the bell-bottom technique: long-term results. J Endovasc Ther. 2010 Aug;17(4):504-9. PubMed PMID: 20681766. Epub 2010/08/05. eng.

19. Telles GJ, Razuk Filho A, Karakhanian WK, Saad PF, Saad KR, Park JH, et al. Dilatation of Common Iliac Arteries after Endovascular Infrarenal Abdominal Aortic Repair with Bell-Bottom Extension. Braz J Cardiovasc Surg. 2016 Apr;31(2):145-50. PubMed PMID: 27556314. Pubmed Central PMCID: PMC5062725. Epub 2016/08/25.

20. Gray D, Shahverdyan R, Reifferscheid V, Gawenda M, Brunkwall JS. EVAR with Flared Iliac Limbs has a High Risk of Late Type 1b Endoleak. Eur J Vasc Endovasc Surg. 2017 Aug;54(2):170-6. PubMed PMID: 28687427. Epub 2017/07/09.

21. Naji F, Srivatsav V, Qadura M, Harlock J, Andrinopoulos T, Iyer V, et al. Evaluating the Effectiveness of Internal Iliac Artery Branched Endovascular Stent Grafts. Ann Vasc Surg. 2017 Jul 06. PubMed PMID: 28689946. Epub 2017/07/12.

22. Dias NV, Resch TA, Sonesson B, Ivancev K, Malina M. EVAR of aortoiliac aneurysms with branched stent-grafts. Eur J Vasc Endovasc Surg. 2008 Jun;35(6):677-84. PubMed PMID: 18378472. Epub 2008/04/02. eng.

23. Simonte G, Parlani G, Farchioni L, Isernia G, Cieri E, Lenti M, et al. Lesson Learned with the Use of Iliac Branch Devices: Single Centre 10 Year Experience in 157 Consecutive Procedures. Eur J Vasc Endovasc Surg. 2017 Jul;54(1):95-103. PubMed PMID: 28495214. Epub 2017/05/13.

24. Karthikesalingam A, Hinchliffe RJ, Malkawi AH, Holt PJ, Loftus IM, Thompson MM. Morphological suitability of patients with aortoiliac aneurysms for endovascular preservation of the internal iliac artery using commercially available iliac branch graft devices. J Endovasc Ther. 2010 Apr;17(2):163-71. PubMed PMID: 20426631. Epub 2010/04/30. eng.

25. Noel-Lamy M, Jaskolka J, Lindsay TF, Oreopoulos GD, Tan KT. Internal Iliac Aneurysm Repair Outcomes Using a Modification of the Iliac Branch Graft. Eur J Vasc Endovasc Surg. 2015 Oct;50(4):474-9. PubMed PMID: 26188719. Epub 2015/07/21.

26. Parlani G, Verzini F, De Rango P, Brambilla D, Coscarella C, Ferrer C, et al. Long-term results of iliac aneurysm repair with iliac branched endograft: a 5-year experience on 100 consecutive cases. Eur J Vasc Endovasc Surg. 2012 Mar;43(3):287-92. PubMed PMID: 22240335. Epub 2012/01/14.

27. Maus V, Kurz P, Sommer CM, Massmann A, Hatopp A, Erpenbach S, et al. The Use of Iliac Side Branch Devices in Patients with Aortoiliac Aneurysm. Rofo. 2016 Aug;188(8):746-52. PubMed

PMID: 27388996. Epub 2016/07/09. Verwendung iliakaler Bifurkationsprothesen bei Patienten mit aorto-iliakalem Aneurysma.

28. Jongsma H, Bekken JA, Bekkers WJ, Zeebregts CJ, van Herwaarden J, Hoksbergen A, et al. Endovascular Treatment of Common Iliac Artery Aneurysms With an Iliac Branch Device: Multicenter Experience of 140 Patients. J Endovasc Ther. 2017 Apr;24(2):239-45. PubMed PMID: 27864456. Epub 2016/11/20.

29. Naji F, Srivatsav V, Qadura M, Harlock J, Andrinopoulos T, Iyer V, et al. Evaluating the Effectiveness of Internal Iliac Artery Branched Endovascular Stent Grafts. Ann Vasc Surg. 2017 Nov;45:247-52. PubMed PMID: 28689946. Epub 2017/07/12.

30. Donas KP, Inchingolo M, Cao P, Pratesi C, Pratesi G, Torsello G, et al. Secondary Procedures Following Iliac Branch Device Treatment of Aneurysms Involving the Iliac Bifurcation: The pELVIS Registry. J Endovasc Ther. 2017 Jun;24(3):405-10. PubMed PMID: 28511617. Epub 2017/05/18.

31. Verzini F, Parlani G, Romano L, De Rango P, Panuccio G, Cao P. Endovascular treatment of iliac aneurysm: Concurrent comparison of side branch endograft versus hypogastric exclusion. J Vasc Surg. 2009 May;49(5):1154-61. PubMed PMID: 19394544. Epub 2009/04/28. eng.

32. Lim CS, Naji Y, Hussain ST, Pleban E, Wiszniewski A, Onida S, et al. Modified Sandwich-graft Technique Employing Aorfix and Viabahn Stent-grafts to Preserve Hypogastric Flow in Cases of Complex Aortoiliac and Isolated Common Iliac Artery Aneurysms Including the Internal Iliac Artery Ostium. Eur J Vasc Endovasc Surg. 2016 Mar;51(3):364-70. PubMed PMID: 26612599. Epub 2015/11/28.

33. Park YE, Lee JH, Yun WS, Park KH. Surgeon custom-made iliac branch device to salvage hypogastric artery during endovascular aneurysm repair. J Korean Med Sci. 2014 Dec;29(12):1678-83. PubMed PMID: 25469069. Pubmed Central PMCID: PMC4248590. Epub 2014/12/04.

34. Adovasio R, Chiarandini S, Calvagna C, D'Oria M, Zamolo F, Pipitone MD, et al. Treatment of Complex Abdominal Aortic Aneurysms with Parallel Graft-Endovascular Aneurysm Repair. Retrospective Analysis of a Single Center Experience and Midterm Results. Ann Vasc Surg. 2017 Sep 22. PubMed PMID: 28943486. Epub 2017/09/26.

35. Wu IH, Chou HW, Chang CH, Lin CF, Chi NH, Wang SS. Crossover chimney technique to preserve the internal iliac artery during endovascular repair of iliac or aortoiliac aneurysms: midterm results. J Endovasc Ther. 2015 Jun;22(3):388-95. PubMed PMID: 25878024. Epub 2015/04/17. eng.

36. Lobato AC, Camacho-Lobato L. The sandwich technique to treat complex aortoiliac or isolated iliac aneurysms: results of midterm follow-up. J Vasc Surg. 2013 Feb;57(2 Suppl):26s-34s. PubMed PMID: 23336852. Epub 2013/01/25. eng.

37. Overeem SP, Boersen JT, Schuurmann RCL, Groot Jebbink E, Slump CH, Reijnen M, et al. Classification of gutter type in parallel stenting during endovascular aortic aneurysm repair. J Vasc Surg. 2017 Aug;66(2):594-9. PubMed PMID: 27743807. Epub 2016/10/17.

38. Massmann A, Mosquera Arochena NJ, Shayesteh-Kheslat R, Buecker A. Endovascular anatomic reconstruction of the iliac bifurcation with covered stentgrafts in sandwich-technique for the treatment of complex aorto-iliac aneurysms. International journal of cardiology. 2016 Nov 1;222:332-9. PubMed PMID: 27500759. Epub 2016/08/09. eng.

39. Tielliu IFJ, Bos WTGJ, Zeebregts CJ, Prins TR, Van Den Dungen JJAM, Verhoeven ELG. The role of branched endografts in preserving internal iliac arteries. Journal of Cardiovascular Surgery. 2009;50(2):213-8.

40. George SG, Joost AvH, George AA, Constantijn EVBH, Athanasios DG, Miltos KL, et al. Systematic Review of Off-the-Shelf or Physician-Modified Fenestrated and Branched Endografts. Journal of Endovascular Therapy. 2015 2016/02/01;23(1):98-109.

41. Tielliu IF, Bos WT, Zeebregts CJ, Prins TR, Van Den Dungen JJ, Verhoeven EL. The role of branched endografts in preserving internal iliac arteries. The Journal of cardiovascular surgery. 2009 Apr;50(2):213-8. PubMed PMID: 19329918. Epub 2009/03/31. eng.

42. Wong S, Greenberg RK, Brown CR, Mastracci TM, Bena J, Eagleton MJ. Endovascular repair of aortoiliac aneurysmal disease with the helical iliac bifurcation device and the bifurcated-bifurcated iliac bifurcation device. J Vasc Surg. 2013 Oct;58(4):861-9. PubMed PMID: 23790453. Epub 2013/06/25.

43. W. L. Gore & Associates I. GORE® EXCLUDER® Iliac Branch Endoprosthesis (IBE): Instructions For Use. 2016.

44. Medical C. Zenith®Branch Iliac Endovascular Graft: guidelines for planning and sizing. 2016.

45. JOTEC ® E-Iliac ® system: Product overview and ordering information. 2013.

NOTES

***Conflicts of interest*—** The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

***Authors' contributions*—** Conception and design: CR, JS, AM; Acquisition of data: CR; Analysis and interpretation of data: CR; Article writing: CR, JS; Critical article revision: CR, JS, AM; Final approval of the article: AM; Overall responsibility: AM.

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TABLES

Table I - Clinical results of hypogastric preservation with the bell-bottom technique.

Authors (year)	N	Mean CIA Diameter (range)	Mean Follow-Up Time	Technical Sucess	Aneurysm Sac Regression	Aneurysm Sac Dilation	Freedom from Secondary Intervention	Endoleak Rate
Torsello *et al*[18] (2010)	89	22.1 ± 3.0 mm (20-30mm)	56.5 ± 2.1 months	97.8%	Not significant	4.4%	91.6% at 5 years	Type I - 3.4% Type II - 2.2%
Naughton *et al*[15] (2012)	166	20 mm (20-28 mm)	22 months (9-38)	-	-	-	89%	-
Alverez M. *et al*[17] (2013)	19	20 mm (18-25mm)	35 months	94.7%	Not significant	-	72.6% at 4 years	Type II – 21%
Telles *et al*[19] (2016)	38	21mm ± 4 mm (15-32mm)	25.8 ± 14.9 months	-	64.7% unchanged or reduced up to 20%	35.3%	84.3% at median follow-up time	Type Ib – 7.8% Type II – 9.8%
Gray *et al*[20] (2017)	128	14mm	53 months	-	-	-	-	Type Ib – 18% in CIA> 20mm and 3.9% in CIA< 20mm

Table II - Clinical results of hypogastric preservation with iliac branches

Authors (year)	N	Mean CIA Diameter (range)	Mean Follow-Up	Technical Sucess	Graft Patency	Branch Occlusion	Aneurysm Sac Regression	Aneurysm Sac Dilation	Buttock Claudication	Freedom from secondary Intervention	Endoleak Rate
Dias *et al*[22] (2008)	22	34 mm (27-41)	20 months (8-31)	91%	74%	27%	56% with CT-FU 1 year	0%	-	82%	Type II – 9% Type III- 4,5%
Vernizi *et al*[31] (2009)	32	40.2 ± 7.9 mm	9.8 months (1-24)	94%	-	0%	30%	-	-	84%	-
Tielliu *et al*[41] (2009)	27	-	16 ± 14 months	96%	-	-	-	-	-	-	-
A. Karthikesalingam *et al*[13] (2010)	196 (9 series)	31,5-39mm (15-78mm)	6-24 months	85-100%	-	12.2%	-	-	6,63%	-	Type I-0,51% Type III- 1,02%
Pua *et al*[8] (2011)	14	39mm (34-57mm)	18.7 months (6-35 mo.)	86%	100%	-	-	7,14%	0%	92,86%	Type II- 14,3% Type III- 7,14%
Parlani et al[26] (2012)	100	40 mm (35-44)	17 months (1-60)	95%	91,4% at 5 years	-	72%	4%	4%	81.4% at 5 years	Type Ib- 2% Type III- 1%
Wong *et al*[42] (2013)	130	34.6 and 31.2	20.3 months (1-72)	94%	81.6% at 5 years	-	67%	0%	-	-	-

Table II – Continuation

Authors (year)	N	Mean CIA Diameter (range)	Mean Follow-Up	Technical Sucess	Graft Patency	Branch Occlusion	Aneurysm Sac Regression	Aneurysm Sac Dilation	Buttock Claudication	Freedom from secondary Intervention	Endoleak Rate
Férnandez-Alonso *et al*[7] (2013)	9	34.8mm (29-50mm)	14.7 months (9-29 mo.)	100%	100%	-	-	-	0%	-	Type II – 15,8%
Jongsma *et al*[28] (2017)	140	37.0-41.4mm	26.6 ± 24.1 months	96.9%	-	9.3%	51.3%	13.1%	4,29%	-	Type Ib- 5% Type III- 2,14%
G. Simonte *et al*[23] (2017)	149	37.0 ± 8.1 mm	44.2 ± 35.1 months	97.5%	90.4% at 10 years	-	-	-	-	91.8% at 9 years	-
Donas *et al*[30] (2017)	575	L: 30.1 ± 11.9 mm and R: 32.6 ± 12.3 mm	32.6 ± 9.9 months	97.6%	94.8%	-	-	-	-	91,1%	Type I- 4,9%

Table III – Clinical results of hypogastric preservation with parallel-grafts.

Authors (year)	N	Mean CIA Diameter (range)	Mean Follow-Up	Technical Sucess	Graft Patency	Branch Occlusion	Aneurysm Sac Regression	Aneurysm Sac Dilation	Buttock Claudication	Freedom from secondary Intervention	Endoleak Rate
Wu *et al*[35] (2015)	14	36 ± 4mm (n=7) 54 ± 22mm (n=6) 12mm (n=1)	14.3 months (6-21)	100%	92,8%	7%	21,4%	0%	14,3%	-	Type I or III- 0% Type II- 21,4% at follow-up
Lobato and Camacho-Lobato[36] (2013)	40	56.2 ± 6.4mm (n=33) 30.6 ± 7.1mm (n=6) 57mm (n=1)	12 months (6-30)	100%	93.8%	-	34,8%	2,2%	0%	100%	Type I or III- 0% Type II- 2,5%
C.S.Lim *et al*[32] (2016)	21	L: 40.0 mm (24-81) R: 37.6 mm (35-87)	17.2 months (5-40)	100%	90.5%	-	66.7%	0%	-	-	-
Massman n *et al*[38] (2016)	24	43 ± 15 mm	15.0 months (1–40)	100%	84.2% in 1 year	-	61.5%	0%	-	-	Type Ib- 6.5%

Table IV – Manufacter's Instructions For Use (IFUs) for current commercially available iliac branches.

GORE® EXCLUDER® Iliac Branch Endoprosthesis (IBE)[43]:

- Adequate iliac / femoral access
- CIA diameter ≥ 17 mm at the proximal implantation zone of the IBE
- EIA treatment
    - Length ≥ 10 mm
    - Diameter range of 6.5 – 25 mm
- IIA treatment
    - Length ≥ 10 mm
    - Diameter range of 6.5 – 13.5 mm
- Adequate length from the lowest major renal artery to the internal iliac artery to accommodate the total endoprosthesis length, calculated by adding the minimum lengths of required components, taking into account appropriate overlaps between components

COOK® Zenith® Branch Iliac Endovascular Graft (IBD)[44]:

- Adequate iliac/femoral access compatible with a 20 French (7.7 mm OD) introduction system
- CIA diameter ≥ 16 mm adjacent to the branch
- Non-aneurysmal EIA fixation segment distal to the aneurysm
    - Length ≥ 20 mm
    - Diameter range of 8-11mm
- Non-aneurysmal IIA segment distal to the aneurysm
    - Length ≥ 10 mm (with 20-30 mm being preferred)
    - Diameter acceptable for proper sealing.

JOTEC® E-liac ® stent graft system[45]:

The stent graft is available in the following lengths and diameters, permitting users to select the product according to the specific indication and the patient's vascular anatomy:

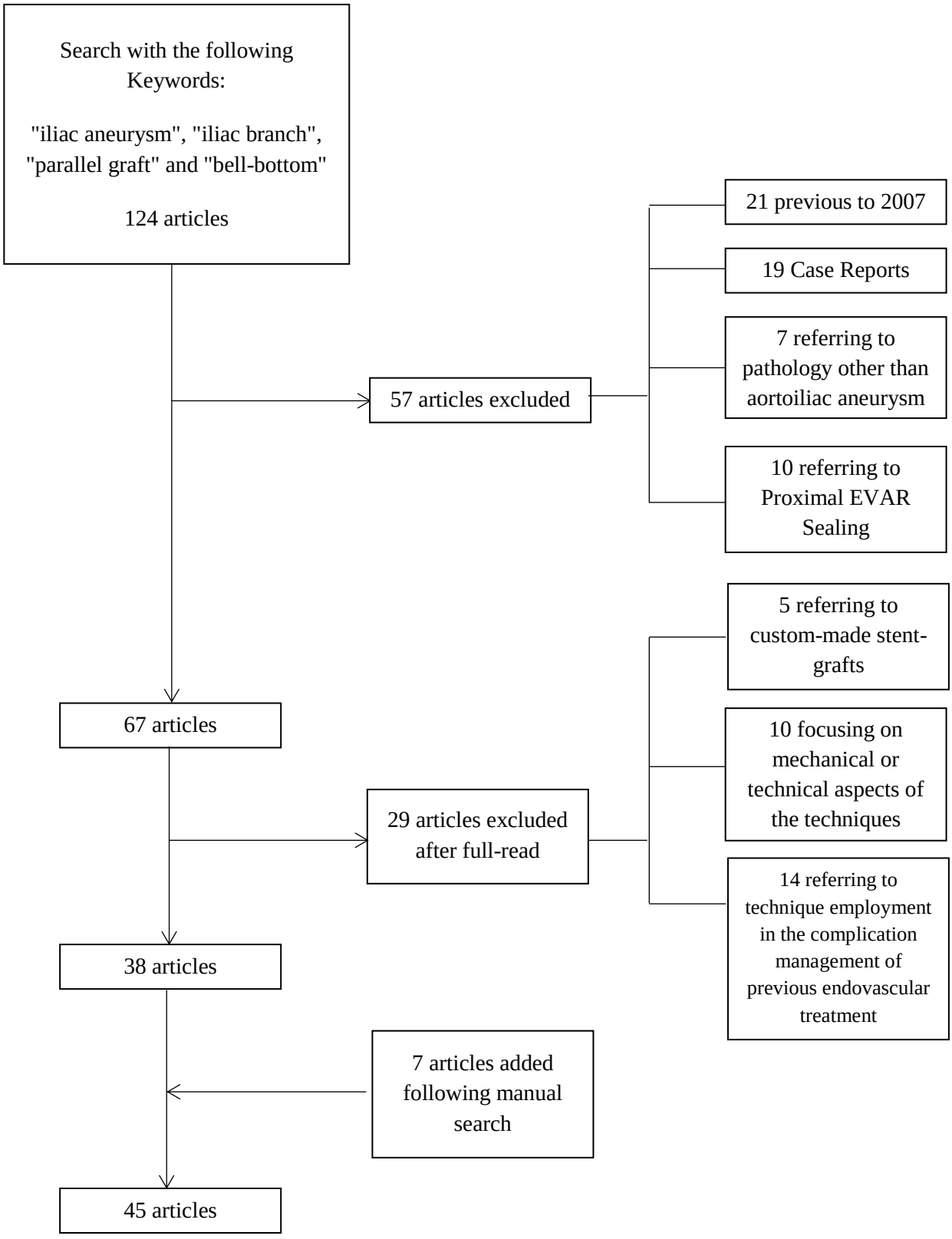
- Total length: 97-121mm
- Proximal
    - Length: 53/65mm
    - Diameter: 14/16/18 mm
- Distal
    - Length: 44/56mm
    - Diameter: 10/12/14mm

Table V – Recommendations for the use of different internal iliac artery preservation strategies in the endovascular repair of aortoiliac aneurysms.

Bell-Bottom: Patients with **CIA diameter ≤24mm** with: • Lower Life Expectancy and/or less active patients • Absence of significant thrombus in the CIA/IIA • Iliac Branch has previously failed
Iliac Branches: Gold-standard treatment option in patients with **CIA diameter >30mm** • Also indicated for smaller CIAs as long as other anatomic features are met and particularly if concomitant AAA is present Should be especially considered in: • Higher life expectancy and/or younger and more active patients • Higher risk of symptomatic pelvic ischemia - Thoraco-abdominal endovascular repairs - Contralateral iliac occlusion
Parallel-Grafts: • Emergency situations • Higher complexity anatomies unsuitable for other techniques

FIGURES

Figure 1- Flowchart demonstrating Evidence Acquisition.



Anexos

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introduction, materials (patients) and methods, results, discussion, conclusions. The introduction should describe the theoretical background, the aim of the study and the hypothesis to be tested. The materials and methods section should describe in a logical sequence how the study was designed and carried out, how the data were analyzed (what hypothesis was tested, what type of study was carried out, how randomization was done, how the subjects were recruited and chosen, provide accurate details of the main features of treatment, of the materials used, of drug dosages, of unusual equipments, of the statistical method ...). In the results section the answers to the questions posed in the introduction should be given. The results should be reported fully, clearly and concisely supported, if necessary, by figures, graphs and tables. The discussion section should sum up the main results, critically analyze the methods used, compare the results obtained with other published data and discuss the implications of the results. The conclusions should briefly sum up the significance of the study and its future implications. For randomised controlled trials it is suggested to the authors to follow the guidelines reported by the CONSORT statement (**http://www.consort-statement.org**).

Review articles. These articles are commissioned by the Editor in Chief or the Managing Editor. They should discuss a topic of current interest, outline current knowledge of the subject, analyze different opinions regarding the problem discussed, be up-to-date on the latest data in the literature. Systematic reviews and meta-analyses must be subdivided into the following sections: introduction, evidence acquisition, evidence synthesis, conclusions. For systematic reviews and meta-analyses it is suggested to the authors to follow the guidelines reported by the PRISMA statement (**http://www.prisma-statement.org**). The text should be 6000-12000 words (17 to 34 typed, double-spaced pages) not including references, tables, figures. No more than 100 references will be accepted.

Special articles. These are articles on the history of medicine, health care delivery, ethics, economic policy and law concerning angiology. The text should be 3000-7000 words (8 to 20 typed, double-spaced pages) not including references, tables, figures. No more than 50 references will be accepted.

Letters to the Editor. These may refer to articles already published in the journal or to a subject of topical interest that the authors wish to present to readers in a concise form. The text must not be subdivided and should be 500-1000 words (1 to 3 typed, double-spaced pages) not including references, tables, figures. No more than 5 references will be accepted.

Guidelines. These are documents drawn up by special committees or authoritative sources.

The number of figures and tables should be appropriate for the type and length of the paper.

PREPARATION OF MANUSCRIPTS

Text file

Manuscripts must be drafted according to the template for each type of paper (**editorial**, **original**

article, **review**, **special article**, **letter to the Editor**, **guidelines**).

The formats accepted are Word (.DOC) and RTF. The text file must contain title, authors' details, abstract, key words, text, references, notes, tables and titles of tables and figures. Figures should be submitted as separate files. The file should not contain active hyperlinks.

Title and authors' details

Short title, with no abbreviations. First name in full, middle name's initial, surname of the authors. Collective name, if any, as last author. Corresponding author marked with an asterisk. Affiliation (section, department and institution) of each author. Name, address, e-mail of the corresponding author.

Abstract and key words

Articles should include an abstract of between 200 and 250 words. For original articles, the abstract should be structured as follows: background (what is already known about the subject and what the study intends to examine), methods (experimental design, patients and interventions), results (what was found), conclusions (meaning of the study). For systematic reviews and meta-analyses, the abstract should be structured as follows: introduction, evidence acquisition, evidence synthesis, conclusions. Key words should refer to the terms from Medical Subject Headings (MeSH) of MEDLINE/PubMed. No abstracts are required for editorials or letters to the Editor.

Text

Identify methodologies, equipment (give name and address of manufacturer in brackets) and procedures in sufficient detail to allow other researchers to reproduce results. Specify well-known methods including statistical procedures; mention and provide a brief description of published methods which are not yet well known; describe new or modified methods at length; justify their use and evaluate their limits. For each drug generic name, dosage and administration routes should be given. Brand names for drugs should be given in brackets. Units of measurement, symbols and abbreviations must conform to international standards. Measurements of length, height, weight and volume should be given in metric units (meter, kilogram, liter) or their decimal multiples. Temperatures must be expressed in degrees Celsius. Blood pressure must be expressed in millimeters of mercury. All clinical chemistry measurements should be expressed in metric units using the International System of Units (SI). The use of unusual symbols or abbreviations is strongly discouraged. The first time an abbreviation appears in the text, it should be preceded by the words for which it stands.

References

It is expected that all cited references will have been read by the authors. The references must contain only the authors cited in the text, be numbered in Arabic numerals and consecutively as they

are cited. Bibliographical entries in the text should be quoted using superscripted Arabic numerals. References must be set out in the standard format approved by the International Committee of Medical Journal Editors (**http://www.icmje.org**).

Journals

Each entry must specify the author's surname and initials (list all authors when there are six or fewer; when there are seven or more, list only the first six and then "*et al*."), the article's original title, the name of the Journal (according to the abbreviations used by MEDLINE/PubMed), the year of publication, the volume number and the number of the first and last pages. When citing references, please follow the rules for international standard punctuation carefully.

Examples:

- Standard article.

Sutherland DE, Simmons RL, Howard RJ. Intracapsular technique of transplant nephrectomy. Surg Gynecol Obstet 1978;146:951-2.

- Organization as author

International Committee of Medical Journal Editors. Uniform requirements for manuscripts submitted to biomedical journals. Ann Int Med 1988;108:258-65.

- Issue with supplement

Payne DK, Sullivan MD, Massie MJ. Women's psychological reactions to breast cancer. Semin Oncol 1996;23(1 Suppl 2):89-97.

Books and monographs

For occasional publications, the names of authors, title, edition, place, publisher and year of publication must be given.

Examples:

- Books by one or more authors

Rossi G. Manual of Otorhinolaryngology. Turin: Edizioni Minerva Medica; 1987.

- Chapter from book

De Meester TR. Gastroesophageal reflux disease. In: Moody FG, Carey LC, Scott Jones R, Ketly KA, Nahrwold DL, Skinner DB, editors. Surgical treatment of digestive diseases. Chicago: Year Book Medical Publishers; 1986. p. 132-58.

- Congress proceedings

Kimura J, Shibasaki H, editors. Recent advances in clinical neurophysiology. Proceedings of the 10th International Congress of EMG and Clinical Neurophysiology; 1995 Oct 15-19; Kyoto, Japan. Amsterdam: Elsevier; 1996.

Electronic material

- Standard journal article on the Internet

Kaul S, Diamond GA. Good enough: a primer on the analysis and interpretation of noninferiority trials. Ann Intern Med [Internet]. 2006 Jul 4 [cited 2007 Jan 4];145(1):62-9. Available from: http://www.annals.org/cgi/reprint/145/1/62.pdf

- Standard citation to a book on CD-ROM or DVD

Kacmarek RM. Advanced respiratory care [CD-ROM]. Version 3.0. Philadelphia: Lippincott Williams & Wilkins; ©2000. 1 CD-ROM: sound, color, 4 3/4 in.

- Standard citation to a homepage

AMA: helping doctors help patients [Internet]. Chicago: American Medical Association; ©1995-2007 [cited 2007 Feb 22]. Available from: http://www.ama-assn.org/.

Footnotes and endnotes of Word must not be used in the preparation of references.

References first cited in a table or figure legend should be numbered so that they will be in sequence with references cited in the text taking into consideration the point where the table or figure is first mentioned. Therefore, those references should not be listed at the end of the reference section but consecutively as they are cited.

Notes

Conflicts of interest; mention of any funding, research contracts; authors' contribution statement; list of the members of the collective name (author's name in full, middle name's initial in capital letters and surname, with relevant affiliation); contributors' names; dates of any congress where the paper has already been presented; acknowledgements.

Tables

Tables should be submitted in the text file. Each table should be created with the Table menu of Microsoft Word table editor, by selecting the number of rows and columns needed. Tabulations are not allowed. Each table must be numbered in Roman numerals and accompanied by the relevant title. Each table must include heading, body and notes, if needed, at the foot of the table. Tables should be referenced in the text sequentially.

Figures

Each figure should be submitted as a separate file. Formats accepted: JPEG set at 300 dpi resolution preferred; other formats accepted are TIFF and PDF (high quality). Figures should be numbered in Arabic numerals and accompanied by the relevant title. Titles of figures should be repeated also in the text file. Figure should be referenced in the text sequentially.

Reproductions should be limited to the part that is essential to the paper.

Histological photographs should always be accompanied by the magnification ratio and the staining method.

If figures are in color, it should always be specified whether color or black and white reproduction is required.